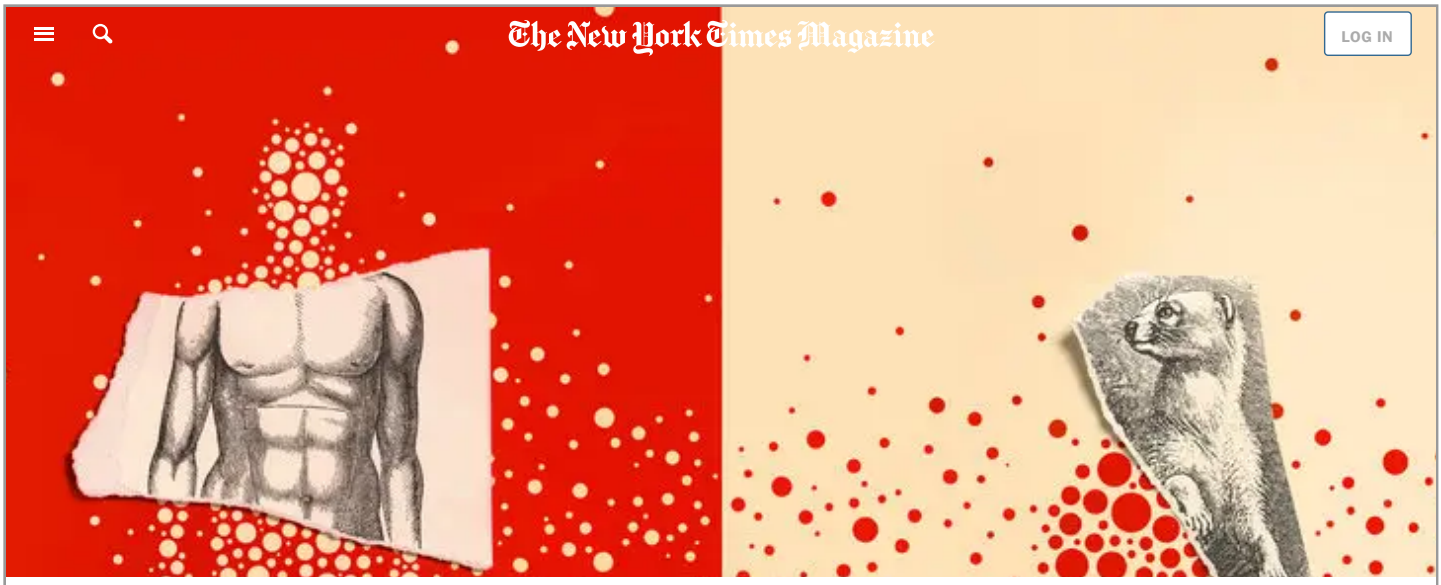
archive.today
webpage capture
Saved from https://www.nytimes.com/2022/01/19/magazine/spillback-a search
no other snapshots from this url
19 Jan 2022 10:42:52 UTC
All snapshots from host www.nytimes.com
Webpage Screenshot
share download .zip report bug or abuse donate



Animals Infecting Humans Is Scary. It's Worse When We Infect Them Back.

Mink farms threaten to become a source of new coronavirus variants — and an object lesson in how 'spillback' can make deadly diseases even deadlier.

By Sonia Shah Illustrations by Tyler Comrie
Jan. 19, 2022, 5:00 a.m. ET

Listen to This Article
Audio Recording by Audm
Listen 37:27

To hear more audio stories from publications like The New York Times, download Audm for iPhone or Android.

A mink farm in northern Utah sat at the end of a narrow, rutted road lined by modest, densely packed ranch houses. The farm consisted of a grassy lot partly enclosed by stakes with wire wrapped haphazardly around them and a small, chain-link swing

gate. Long, narrow mink sheds a few yards beyond the gate were so close to the road that I could see inside their dark interiors.

The smell from the sheds was intense. Mink keep intruders away from their territories by emitting an odor from their anal scent glands that is widely considered to be more pungent than that of skunks. (A thoroughfare in a nearby city that is home to several mink farms is colloquially known as "Satan's butthole.") A neighbor, an adolescent girl with a mass of black curls, offered to help me find the farmer, and I waited as she unlatched the gate and marched into the mink sheds in her flip-flops. She located the farmer in one of the sheds, poked her head out and called me over.

Having long been targeted by anti-fur activists, mink farms don't announce themselves with signposts or list their names and addresses in directories. When I visited in July, the $20 billion global mink industry was under scrutiny for a different reason: Mink farmers had been battered by the coronavirus, which first erupted among captive mink in Europe in late April 2020 and on United States farms four months later. By June 2021, scientists estimated, the virus had infected as many as seven million mink on more than 400 farms in Europe and North America, killing more than 700,000 of the animals, a death toll orders of magnitude greater than that borne by any other nonhuman species. By the summer of 2021, coronavirus had infected thousands of mink on a dozen farms in Utah. Four farms in the state were still under quarantine.

Inside the shed, the still air was dense with flies. On either side, rows of wire cages stacked waist high contained the intertwined bodies of mink. Most were silently prostrate on their backs, their paws limp in the air, passed out in the nearly 100-degree heat. Mink waste piled up under their cages in low, long ridges. At the end of the narrow dirt aisle between the sheds, the farmer sat on a small tractor outfitted with a special attachment that squeezed plops of pinkish meat paste on top of the cages. He wore a headlamp, a Walkman and an affable expression as he looked up at me. I made my way down the aisle between the ridges of mink waste, feeling grateful I wasn't wearing flip-flops.

The farmer happily chatted with me about the 13,000 mink he keeps on the farm, which freely exchange aerosols with him, one another and any animal that might happen to follow the stench emanating from his unsecured sheds. "We may have had a few mink die that might have been from the Covid," he mused when I asked him how his mink had fared in the first wave of the pandemic. "We didn't think it was anything, so we didn't test them."

The probability that this latest generation of mink might be infected was, if anything, greater than it was the previous summer. Covid-19 cases in Utah were higher, and nearby Salt Lake City was

a center of anti-vaccine sentiment in the state. And while the farmer had already vaccinated his mink against distemper and other diseases, he had no plans to buy the coronavirus vaccine that the pharmaceutical company Zoetis had developed for mink and other animals. Even if he did, that vaccine, like its human counterparts, would only reduce disease in mink. It would not prevent infection and probably would not prevent transmission either, a Zoetis executive told me.

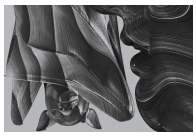
The farmer wore thick leather gloves to protect his hands from the minks' powerful bites, but he did not wear a mask. I was fully vaccinated and had tested myself to ensure I wasn't infected, but he didn't ask me about my vaccine status nor did he ask me to wear a mask. (Masking on mink farms, like vaccinations and testing, were not legally required.) Before I left, I asked if I could take his photograph. He reached into a cage, grabbed a mink by the torso and held it up for the camera. The mink opened its mouth, inches from the farmer's grinning face, and screeched in terror.

The Covid-19 pandemic has familiarized the world with the word "spillover," which means when microbes in the bodies of animals spread into those of humans. Less discussed is spillover's mirror image, "spillback," also known as "reverse zoonosis," by which microbes move from humans into nonhuman animals. Not every pandemic-causing pathogen can spill back into nonhuman species: Some become so genetically partial to Homo sapiens that they can no longer make the crossing, while others may never get the chance. But those that can spill over and back expand their reign in the natural world, with unexpected results for both human and nonhuman animals. A spillback can ignite epidemics in wild species, including endangered ones, ravaging whole ecosystems. It

can establish new wildlife reservoirs that shift the pathogens' evolutionary trajectory, unleashing novel variants that can fuel new, dangerous waves of disease in humans.

Some scientists suspect, for example, that before erupting in humankind, Omicron may have brewed in a nonhuman animal as a result of a spillback. Its unusually large number of mutations compared with the original variant — around 50, including more than 30 embedded in its spike protein, nearly three times as many as the Delta variant — suggest a recent past inside an unusual host that forced it to evolve novel adaptations to survive.

Which species that unusual host hailed from remains obscure. Seven of Omicron's mutations are linked to adaptation in rodents. Any likely contender would have to be a species able to contract the coronavirus from humans and also to pass it along to both humans and nonhuman animals. So far, other than the still-shadowy creature that likely ferried the coronavirus from bats to humans in the first place, the only nonhuman species known to have accomplished that feat is Neovison vison, the American mink. There's no evidence that mink played any role in incubating the Omicron variant, but their biology and living conditions render them ideal hosts for incubating others.



How Humanity Unleashed a Flood of New Diseases
June 17, 2020

When the novel coronavirus first erupted on two mink farms in the Netherlands, the world's fourth-largest producer of mink pelts, in late April 2020, the Dutch government shut down streets around the farms, conducted mandatory screenings of all mink farms, quarantined infected farms and instructed farmworkers to don personal protective equipment. It didn't work. By early May, two more mink farms reported outbreaks. By the end of the month, the Dutch government started gassing all the mink on affected farms, many of them kits just a few weeks old. They screened any mink who died on a mink farm for coronavirus. They banned transport of mink and of mink manure. That didn't work, either. By the end of July, investigators detected the coronavirus on 27 mink farms in the Netherlands. Jim Keen, a former United States Department of Agriculture veterinary epidemiologist, calculated that each farm produced enough virions to infect millions of people — an explosion of virus that was equivalent, he said, to "having a decent-sized stadium where everyone is infected at the same time."

In the months after coronavirus first appeared on Dutch mink farms, outbreaks popped up in mink-farming countries across Europe. In Denmark, coronavirus infected more mink than people. As in humans, the virus could spread among mink

asymptomatically, and even farms that recovered from outbreaks could be reinfected again, studies showed. Finally, after the mink incubated a novel strain of the virus, the Danish prime minister ordered the mass slaughter of the nation's 17 million farmed mink and a dozen countries in Europe, including the Netherlands and Poland, banned or phased out fur farming. Austria and the Netherlands spearheaded an effort to end fur farming across the European Union.

Spillbacks confound our containment strategies. In theory, we can tame pathogens that prey exclusively on Homo sapiens. We can change our behaviors to make transmission difficult. We can stop drinking waste- contaminated water, making the transmission of cholera difficult. We can protect our homes with mosquito screens, making the transmission of malaria difficult. We can eradicate a pathogen altogether, as we did smallpox through a global vaccination campaign. But once a pathogen spills back from humans into wild animals, those options slip away, for we have even less control over the behavior of nonhuman animals than we do over our fellow humans. "Well, now it's in fish, it's in frogs, it's in primates," the disease ecologist Barbara Han says. "How are you going to get rid of that?"

While the United States has spent millions of dollars surveilling low-income countries overseas for possible spillovers from wild animals into humans, in the United States, disease surveillance in wild species is mostly passive and opportunistic — designed to detect large-scale die-offs of wild animals, not the silent establishment of a pathogen in a new reservoir species. Finding evidence of that requires actively and systematically looking for it. This August, the U.S.D.A. announced a new $300 million program to strengthen disease surveillance in both domestic and wild animals, but until it gets underway in the next couple of years, "the truth is," the coronavirus expert Linda Saif says, "there is very little funding to study these scenarios where the virus is in humans and might spill back into animals." It's likely that we may detect only that subset of coronavirus spillbacks that happen to re-emerge in humans, and in those cases only in the rearview mirror, by piecing together genetic and other clues to reconstruct their prior forays through the bodies of animals.

Describing the gaps in disease surveillance of nonhuman species, the veterinary pathologist Tracey McNamara, who was involved in the discovery of a West Nile virus outbreak in New York City in 1999, after first observing it in birds, said: "I am ripping my hair out. Our national emblem is the bald eagle. But watching all this unfold, we need to change it to the ostrich."

It's not just that our surveillance systems are unsystematic. Their underlying logic creates gaps that actively obscure the spillback phenomenon. For spillback pathogens, cities full of people, colonies

of free-living animals and herds of captive animals are an unbroken continuum of flesh and tissue to exploit, but for our surveillance systems, humans, wildlife and domesticated animals are separated into three distinct biotic spheres, monitored by different entities with peculiar jurisdictions and distinct technical approaches. Those creatures that defy our ontological categories — the supposedly tamed captives that go feral, for example, or the wild creatures intimately embedded in civilized spaces — can escape notice entirely.

The way we talk about the movement of pathogens tends to obscure a confounding reality. We talk about microbes that "spill" over and back, as if they rightly belong in some container other than our bodies, in which their presence is accidental. We talk about microbes that "jump" from animal bodies into ours, as if they must surmount a chasm to find their way from one to the other. But we are animals among animals, sharing a planet roiled by microbes. For many pathogens, the borders between species are as permeable as a sponge. By engineering strange and intimate encounters between other infected species, we inevitably implicate our own bodies too.

Take morbillivirus, a family of viruses that is among the deadliest and most infectious viruses on the planet, killing up to 95 percent of those infected for the first time. In humans, the virus is known as measles. But that moniker obscures its travels across species, both before and after its tenure in Homo sapiens. Morbillivirus spilled over into humans from cattle, in whom it causes a devastating disease known as rinderpest, or "cattle plague," sometime in the 10th century. The virus surged through human populations in waves in the Old World and then in the New World following the era of European conquest. But its fitful journey did not stop in Homo sapiens.

The Coronavirus Pandemic: Latest Updates ›
Updated 8 minutes ago

- Japan places Tokyo and 12 other prefectures under a quasi-state of emergency because of Omicron.

- Biden promises free masks in the 'largest deployment' of such equipment in U.S. history.

The bodies of Native Americans, many of whom died of measles, were likely scavenged by dogs; conquistadors may have even fed native children to dogs, as depicted in the 16th-century account, by the Spanish priest Bartolomé de Las Casas, of Europeans' colonization of the Americas. In 1735, a novel disease that looked a lot like morbillivirus in humans broke out in dogs in Ecuador and Peru. Because the virus causes distinctive lesions on the teeth of puppies, the veterinary pathologist Elizabeth Uhl determined that it had not been present in pre-Columbian dogs, whose entombed teeth she examined. Based on those findings and other research, Uhl and her colleagues suggested in a 2019 paper that morbillivirus must have spilled back from people into dogs. It's now a major pathogen of dogs, causing the disease known as distemper.

That spillback allowed the virus to conquer a wide range of other domesticated animals and wild animals. Its list of conquests now includes species from five different orders and two families of nonhuman primates, from dolphins and porpoises to various endangered species. Distemper reached farmed mink from infected dogs. The mink industry's subsequent attempt to contain distemper tipped another line of dominoes, unleashing a pathogen even more difficult to control. In the mid-20th century, mink farmers typically used a distemper vaccine on their farmed mink consisting of the ground-up spleens of distemper-infected mink mixed with saline, but unknown to them, the concoction included a pathogen now known as Carnivore amdoparvovirus-1. The growing international trade in specially bred mink spread the virus to mink farms around the world.

Mink farmers soon found out that amdoparvovirus-1 was even harder to contain than distemper. The viral infection caused a progressive wasting syndrome that could kill infected minks and their unborn kits. Worse, the virus was highly durable in the environment and, unlike distemper, resistant to vaccines. Once infected with amdoparvovirus-1, mink farms became "perpetual reservoirs of these viruses," the microbiologist Andrew Lang says. To eradicate it, mink farms would need to slaughter all their mink and rebuild their mink populations from scratch.

By the time the mink industry adopted measures to prevent amdoparvovirus-1 from entering their farms — by protecting uninfected mink from infected mink, measures that would do little to protect farmed mink from pathogens carried by infected humans — amdoparvovirus-1 had spilled back into wild species. That's because mink farms are notoriously leaky. Cognitively complex and communicative, mink regularly escape the confines of fur farms. People in mink-farming areas like the Utah valley post on

private Facebook groups about escaped mink that turn up in their yards, terrorizing their pets and killing their backyard chickens. Animal-control officers won't always collect escaped mink, an animal advocate in Utah told me, because they consider them "wild" animals outside their purview. Mink farmers don't want them back either, because of the risk they may have interacted with wild mink and picked up a pathogen such as amdoparvovirus-1.

That leaves escapees free to take amdoparvovirus-1, coronavirus or any other pathogen they pick up on the farm into the wild. They do. In one study, 82 percent of the wild mink living in an Ontario county where mink farms were common had antibodies to amdoparvovirus-1, while none of the wild mink studied in a distant, non-mink-farming county did. Amdoparvovirus-1 has also been discovered in British Columbia in over 41 percent of wild adult mink and nearly 4 percent of martens, and in more than a quarter of striped skunks in California. Scientists don't know how prevalent amdoparvovirus-1 was in wild populations before the mink-farm outbreaks. Now, however, they suspect that its ravages are contributing to the decline of wild mink in Canada and to the dire plight faced by the native European mink in Europe, one of the continent's most threatened mammals.

Amdoparvovirus-1-infected mink on farms may have spread the virus to humans too. A 2009 paper in Emerging Infectious Diseases describes the cases of two mink farmers in Denmark who fell ill with a strange disease that appeared similar to the illness that amdoparvovirus-1 causes in mink. One farmer had to be repeatedly hospitalized; another had to have his leg amputated, before dying at age 40. Scientists found amdoparvovirus-specific antibodies and amdoparvovirus DNA in both.

Mink belong to the mustelid family of animals, which includes weasels, badgers, otters, martens, wolverines and ferrets. Ferrets' vulnerability to respiratory pathogens is so similar to our own that scientists who study respiratory diseases commonly use them as experimental subjects. Scientists had pinpointed mink as a likely animal model in which to study the pathogenesis of coronaviruses 16 years ago, in the wake of the first global SARS outbreak. The lung cells of Neovison vison, scientists reported in 2006, have ACE-2 receptors to which SARS coronaviruses can bind.

The Coronavirus Pandemic: Key Things to Know

The Omicron surge. As case counts and hospitalizations reach record highs, reports of falling infection rates in parts of the U.S. offered a hint of good news. But officials warned that Omicron has not yet peaked nationally and that there's no guarantee the variant will lead to enough natural immunity to end the pandemic.

Mink farms offered uniquely amenable conditions for coronavirus to spread. Unlike humans, who can take precautionary measures to avoid contracting the coronavirus, caged mink are trapped in a high-transmission environment, in wire cages the size of cat travel crates, lined up in long rows in sheds that house thousands of animals. Such conditions are as salutary for the spread of respiratory viruses as a high-density prison.

And unlike a prison, a mink shed has no plumbing. "We focus a lot on the respiratory transmission among people," Jonathan Epstein, a zoonotic-disease ecologist, says, "but it's important to remember

that this is also a GI-tract virus, and it's shed in the stool." While we flush our own infected excreta down porcelain toilets, the excreta of mink collects under their cages in dank mounds in which coronavirus can remain infectious for days, long enough to be aerosolized when farmworkers shovel it away.

It's probable that the factory-farm conditions that minks are subjected to make them especially susceptible to microbial pathogens. Notwithstanding their undeniably adorable exteriors — alert, wide-set eyes, dainty, partly webbed paws and long furry bodies — mink are not sociable herd animals like cows, sheep, chickens and pigs, who have been under human domestication for thousands of years, exchanging microbes back and forth with one another and with us. They are solitary, meat-eating predators, unaccustomed to life in intimate proximity to other individuals. Just how the stress of crowding affects mink is unknown, though it is thought to suppress their immune systems. Farmed mink are famously vulnerable to pathogens such as distemper and influenza. Mink farmers must pump them up with vaccinations to keep them alive for the handful of months it takes for them to grow thick fur.

I was told by Michael Whelan, then a mink-industry spokesman, that farmers in the United States had developed "strict biosecurity measures" to prevent microbial transmission between humans and animals on mink farms. Livestock operations — such as poultry farms, for example — often require that workers wear Tyvek suits, masks and bootees and "shower-in" and "shower-out" of the fully sealed sheds where captive animals are kept. And yet many of the mink farms I visited in Utah didn't even have adequate fencing around their borders. The rickety perimeter gate around one farm I saw was open to passing traffic, including the cows in an adjacent clearing, the deer of which nearby roadway signs warned and a band of feral cats that slinked onto the farm's gravel lot just yards from the doorless mink sheds.

Unlike in Europe, health officials in the United States did not conduct active surveillance on mink farms for coronavirus, relying instead on mink farmers to self-report outbreaks. Publicly, industry representatives said they took the risk of coronavirus incursions seriously, but privately, many were almost dismissive about the threat the virus posed. One mink farmer, Joe Ruef, described coronavirus in mink as a "nonevent" when we spoke by phone. The industry trade group, Fur Commission USA, called it a "supposed 'public health threat,'" in an email to its members that was leaked to activists and shared with me. And when word got out that I was visiting Utah mink farms, Fur Commission USA sent out a "security alert" to its members, with a photograph of my rental car and its license plates. "DO NOT let her on to your property," and "under no circumstances allow her near the mink sheds," it read, because "any pictures or documented cases of ranches that are not

following the recommended biosecurity protocols could damage our efforts to defend the US producers."

As a relatively small industry that sells most of its animal products overseas as garments rather than as food, mink farms have escaped most regulatory oversight. Federal laws that pertain to animals — like the Animal Welfare Act and the Humane Slaughter Act — do not cover animals on fur farms. Few states require mink farms to be licensed or inspected; none require veterinary oversight. Like most states, Utah has no regulations on fur farming at all. Even the minimal containment strategies devised for infected mink farms proved difficult to implement. In Utah, mink farmers were "fairly resistant to having anyone come onto their facilities," the Utah state veterinarian Dean Taylor told me. In internal correspondence acquired through public-records requests, Utah health department officials discussed an infected farm that the department was not permitted to access even for testing. Unregulated, secretive mink farms, Han says, are "not that different, if you think about it, from these captive wildlife farms that we hear about in Asia."

On the 12 mink farms that reported outbreaks, health officials implemented quarantines, testing protocols and trapping programs to capture and test nearby animals. Unlike in Europe, there were no culls of susceptible or infected mink. While in 2014 and 2015 the U.S.D.A. paid $200 million to compensate farmers for culling 50 million farmed birds to short-circuit an outbreak of avian influenza, the agency had no budget to do the same to prevent coronavirus from exploding on mink farms.

The mink outbreak that began in August 2020 in the United States eventually engulfed 18 farms in four states. Meanwhile, the seepage of farmed mink into the broader environment continued as usual. Activists "liberated" captive mink as they have for years, sneaking onto mink farms in Utah and Idaho and unlatching the cages of 2,000 mink, who fled into the moonlight. Scientists for the U.S.D.A. and the Centers for Disease Control captured more than 250 mink in and around Utah mink farms that were "able to interact with other wildlife," government scientists wrote in a 2021 paper in the journal Viruses. A third were infected with coronavirus. How many others successfully escaped, the virus in tow, is unknown.

Despite piecemeal surveillance, scientists in the United States have detected the pathogen's spread into at least two free-living wild species. U.S.D.A. scientists discovered coronavirus in a wild mink they trapped near a pile of mink carcasses on a quarantined mink farm in Utah and discovered antibodies to the virus in 40 percent of samples taken from white-tailed deer in Illinois, Michigan, New York and Pennsylvania. In an unpublished study, Penn State veterinary microbiologists reported finding viral RNA in a third of samples taken from white-tailed deer in Iowa. Presumably, the wild mink contracted the virus from infected mink farms. The white-tailed deer were probably infected by humans, with whom they come into frequent contact because of suburban sprawl's encroachment on their habitat. These studies are but a peek into the pathogen's travels into the nonhuman world. No study analyzed samples collected randomly, so results can't be extrapolated to estimate the prevalence of coronavirus in wild species.

In both the United States and in Europe, coronavirus variants incubated on mink farms turned up in people, including those with no association to mink farming. Health officials detected at least three: the Cluster Five variant (now extinct), which was first detected in captive mink and farmworkers in Denmark; the Marseille-4 variant, which first showed up in humans in a mink-farming area of France, with 13 mutations never seen before and presumed to originate in mink; and the Michigan mink variant, which was discovered in mink farmworkers and also a taxidermist who had no known links to mink farms. That meant that the variant, as the state's Department of Health speculated in April 2021, is "already circulating in the community." There is so little genetic sequencing of the viruses infecting people in the United States that it is "impossible to know for sure."

The Covid outbreak on United States mink farms eventually subsided at the end of the year after farmers slaughtered 80 to 90 percent of their animals to sell their pelts. But so long as the novel

coronavirus lurks among us, susceptible species beckon. The range of species that are biologically vulnerable to coronavirus infection is broad. The enzyme ACE-2, a receptor to which the virus binds, appears to be essential for mammals, who have retained the genes that code for it despite taking otherwise divergent evolutionary paths. With each new host comes new possibilities to evolve new modes of transmission and disease pathologies, which can extend the range of possible hosts yet again. Species that are not susceptible to today's variants, for example, may be vulnerable to tomorrow's, a discovery made serendipitously when researchers found that the Beta and Gamma variants could infect lab mice while the original Alpha strain — with which most susceptibility studies are conducted — could not.

Each spillback expands ecological opportunities for the next. An infected wild mink means the pathogen's opportunities to colonize novel species are no longer limited to intimate encounters between nonhuman animals and infected hunters, farmers or other humans who regularly come into close contact with wild and captive animals. A confrontation with a wild mink hunting along the canyons of Utah or a sniff of the mink manure that crop farmers spread on their fields might suffice. Infected deer mean that a brush against the light film of deer saliva left behind on grazing lands might do as well.

A typical depiction of coronavirus in humans and animals, in which the figure of the human lies at the center with an array of microbially infested animals encroaching upon her, erases such interspecies transmissions. But as spillbacks show, the directionality of viral spread is not one-way — nor is humanity its central target.

Still, the novel coronavirus's radiation into the nonhuman world poses a singular menace for Homo sapiens. Simply by originating in strange bodies beyond the reach of our surveillance and control measures, spillback pathogens are likely to be more disruptive than variants brewed in our fellow humans. The variants they unleash can be more dangerous for us, too. In part, that's a result of math: By providing more opportunities for replication and evolution, each new spillback species increases the likelihood of new variants that could circumvent our fortifications entirely, or in entirely new ways. But the heightened probability is also qualitative, embedded in the nature of our kinship with nonhuman species that are biologically similar enough to share pathogens but with social behaviors and immune responses alien to our own. Pathogens that rely on social contact often evolve toward lower virulence as a trade-off for greater transmissibility, but spillback allows them to escape that virtuous circle, with potentially devastating consequences.

Saif said the coronaviruses that preceded Covid-19 dynamically

cycled through species, including sparrows, pigeons, bats, pigs, alpacas, cows, chickens, chimpanzees, dogs, cats and humans, in a dizzying history stretching back centuries. The eruptions she described were much more than human pandemics. They were multispecies events. The Covid-19 pandemic may become one, too. Perhaps it already is.

Sonia Shah is a science journalist and the author of "The Next Great Migration: The Beauty and Terror of Life on the Move" and "Pandemic: Tracking Contagions From Cholera to Coronaviruses and Beyond."

The New York Times

Go to Home Page »

NEWS

OPINION

ARTS

LIVING

LISTINGS & MORE

© 2022 The New York Times Company

NYTCo Contact Us Accessibility Work with us Advertise T Brand Studio Your Ad Choices Privacy Policy Terms of Service Terms of Sale Site Map Help Subscriptions